Title: UPGRADED IMAGE STREAMING TO LEGACY AND UPGRADED DISPLAYS

Abstract: Display system and method for displaying image data comprising (a) at least one input source encoding images to be displayed in a first format with a first resolution and in a second format with a second resolution higher than the first; (b) a first display for displaying images with the first resolution and a second display for displaying images with the second resolution; (c) a shared resource network linking the input source with the first and second displays; wherein images encoded in the first format are sent over the shared resource network through a first cable and a first part of each image encoded in the second format with the second resolution is sent over the shared resource network through the first cable and a second part of each image encoded in the second format with the second resolution is sent over the shared resource network through a second cable.
UPGRADED IMAGE STREAMING TO LEGACY AND UPGRADED DISPLAYS

The present invention relates to methods, systems, encoders and decoders, e.g. for streaming of images and/or video data e.g. streaming of new or updated higher resolution images over legacy networks as well as software for carrying out any of the methods.

Background
In operating rooms at present, integration is the key to efficient surgical workflow. AV (Audio Visual) systems still in use in many operating rooms have limited integration possibilities, demand extensive cabling, and result in cluttered and complicated configurations. This complexity presents challenges in the surgical environment, where flexibility and scalability are critical to operational efficiency.

A fully IP-centric solution for image distribution in the operating room is now usually adopted in more recent ORs (Operating Rooms). In those ORs, the system architecture has been specifically designed to meet the performance demands and the unique requirements of the surgical suite, such as high-quality imaging, ultra-low latency, and real-time communication.

Examples of such networked based surgical systems or networked operating rooms are described in e.g. WO 2007/073420 “Streaming Video Network System” and EP 2081 124A2 “Networked based endoscopic surgical system”.

When an operating room is installed, it usually integrates off-the-shelf equipment of the latest generation. For instance, around 2005, the format of images transferred over the network would have been Full HD (e.g. 1080p). In the example of figure 1, full HD cameras 2 and 4 would generate full HD images for a full HD display 7. AV-to-IP encoders 3 and 5 (like e.g. the MNA-120 supplied by Barco NV, Belgium) take in baseband video data and convert these to IP streams for transportation over a standard high bandwidth IP network 1. The decoder 6 reconverts these raw IP packets to DVI video signals for display on display 7. The IP streams can also be received by computers and/or servers like 8 for e.g. for archiving.

In some networked based solution like Nexxis™ from Barco NV, Belgium, a "management suite" on a computer 9 allows management and monitoring of the IP streams between the encoders and decoders, facilitating configuration and management Integrated within a user interface. The "management suite" software allows distribution of high quality video,
audio, keyboard and mouse towards any destination with a single touch on the screen. For instance, the packets generated by the encoder 3 can be directed towards the decoder 6 in order to display the images captured by camera 2 on display 7 while the packets generated by encoder 5 are directed towards computer 8 for display and storage on that computer. This can be done with a user interface where it merely suffices to drag a source (icon associated with e.g. camera 2) and drop it on a sink (e.g. icon associated with display 7).

As the operating room is upgraded, new equipment can be added as illustrated on figure 2. The new equipment can be more advanced than the one originally installed. For instance the HD camera 4 of Fig. 1 can be replaced by a state of the art camera 10 capturing images of higher resolutions (e.g. a 4K camera). New displays like display 12 capable of displaying images at a higher resolution are connected to the network 1 to take advantage of the increased resolution of camera 10. 4K resolution, also called 4K, refers to a display device or content having horizontal resolution of the order of 4,000 pixels. Several 4K resolutions exist in the fields of digital television and digital cinematography. In the movie projection industry, Digital Cinema Initiatives (DCI) is the dominant 4K standard. The DCI 4K resolution standard is defined as 4096 x 2160 pixels (256:135, approximately a 1.9:1 aspect ratio).

If the 4K content generated by camera 10 is directed to HD display 7 problems may occur. Indeed, while a 4K display might be able to display HD content, an HD display having been manufactured without taking the existence of the 4K format into account might be incapable of displaying a 4K image at all.

One solution to avoid having to replace the encoders, decoders and/or displays of earlier generations when equipment designed to operate with images of a different format, is to let both image formats (HD/1080p and 4K in this example) coexist in one way or another. 1080p (also known as Full HD or FHD and BT.709) is a set of HDTV high-definition video modes characterized by 1080 horizontal lines of vertical resolution and progressive scan, as opposed to interlaced. The term usually assumes a widescreen aspect ratio of 16:9, implying a resolution of 1920x1080 (2.1 megapixel) and is often marketed as "Full HD".

The drawback of that solution is that the amount of data to be streamed increases. If HD-1 080p images were originally streamed at a rate of 30 or 60 frames per second and without compression, it could be done with a single 10Gb per second link.
If HD-1 080p images are to be streamed at the same rate in parallel with 4K images without compression, two or more 10Gb per second links are required.

In US20130314495 "Multi-layer backwards-compatible video delivery for enhanced dynamic range and enhanced resolution formats", the two different formats (e.g. 4K and HD) are encoded together into a first and a second stream making use of base and enhanced layers. The first stream is sufficient to reconstruct the first format (e.g. HD) while the first and second streams are both used to reconstruct the second format (e.g. 4K). Use of base and enhanced layers in this way requires decoding and reconstruction to retrieve the original video signals. A possible issue with the technique disclosed in this document is the "lag" introduced by the decoding and reconstruction of the first and/or second format. Such a lag can be incompatible to allow proper eye to hand coordination if e.g. a surgeon is operating in remote (i.e. the patient and the surgeon are not at the same geographical location and a robot controlled by the surgeon is used).

Depending on the resolution and the frame rate of the images to be streamed, one may exceed the bandwidth of a single cable. For instance, the bandwidth required to stream the same images in 4K (8 million pixels) and HD (2 million pixels) formats is well above that of a single 10 GE cable (also known as 10 Gb Ethernet i.e. a cable whose bandwidth allows transmission of 10 gigabits per second).

A solution is required to allow the upgrade of existing network based display systems with as little modifications as possible. In particular a solution is required to allow transfer of higher resolution images using the existing network based display systems with as little modifications as possible.

**Summary of the Invention.**

It is an object of the present invention to provide methods and means including software and computer program products to allow the distribution of image data, e.g. digital data, in different formats over a network to which displays, e.g. digital electronic displays, are connected to be able to display the image data received in at least one of the different formats. The image data can be digital data and the image data provides information to drive pixels of a display. A displayed image has an aspect ratio and luminance values are defined by a number of digital values, e.g. binary values for determining not only the luminance of each display pixel but also colour. A format can be defined, for example by a resolution, a frame rate and a number of bits per pixel, e.g. the latter defining a colour
depth and luminance of each pixel of a displayed image.

In a first aspect of the invention, a display system, e.g. a digital electronic system is provided for displaying image data for use with (a) at least one input source encoding images to be displayed in a first format, (e.g. with a first resolution) and in a second format, (e.g. with a second resolution higher than the first); (b) a first display for displaying images encoded in the first format, (e.g. with the first resolution) and a second display for displaying images encoded in the second format, (e.g. with the second resolution); the system comprising (c) a shared resource network for linking the at least one input source with the first and second displays; wherein the images encoded in the first format, (e.g. with the first resolution) are sent over the shared resource network through a first limited bandwidth link such as for example for at least a part of the network a first cable and wherein a first part of each image encoded in the second format, (e.g. with the second resolution) is sent over the shared resource network through the first limited bandwidth link such as for example the first cable and a second part of each image encoded in the second format, (e.g. with the second resolution) is sent over the shared resource network through a second limited bandwidth link such as for example for at least a part of the network a second cable. Images encoded in the first format can have a first resolution, a first frame rate and a first number of bits per pixel. Images encoded in the second format can have a second resolution, a second frame rate and a second number of bits per pixel. The product value of the second format, i.e. the product of the resolution, the second frame rate and the second number of bits per pixel is higher than the product value of the first format, i.e. the product value of the first resolution, the first frame rate and the first number of bits per pixel. Images encoded in the first format require to be sent across a network with a first bit rate and hence require a connection with a first bandwidth. Images encoded in the second format require to be sent across a network with a second bit rate larger than the first bit rate. The image data can be from still images such as scanned images (e.g. MRI, CTScan images) or from videos.

In a second aspect of the invention, a display system, e.g. a digital electronic system is provided for displaying image data for use with a shared resource network for linking at least one input source with first and second displays, the system comprising (a) the at least one input source encoding images to be displayed in a first format, (e.g. with a first resolution) and in a second format, (e.g. with a second resolution higher than the first); (b) the first display being for displaying images encoded in the first format, (e.g. with the first resolution) and the second display being for displaying images encoded in the second format (e.g. with the second resolution); wherein the images encoded in the first format
(e.g. with the first resolution) are to be sent over the shared resource network through a first limited bandwidth link such as for example for at least a part of the network a first cable and wherein a first part of each image encoded in the second format, (e.g. with the second resolution) is to be sent over the shared resource network through the first limited bandwidth link such as for example the first cable and a second part of each image encoded in the second format (e.g. with the second resolution) is to be sent over the shared resource network through a second limited bandwidth link such as for example for at least a part of the network a second cable. Images encoded in the first format can have a first resolution, a first frame rate and a first number of bits per pixel. Images encoded in the second format can have a second resolution, a second frame rate and a second number of bits per pixel. The product value given by the product of the second resolution, the second frame rate and the second number of bits per pixel is higher than the product value given by the product of the first resolution, the first frame rate and the first number of bits per pixel. Images encoded in the first format require to be sent across a network with a first bit rate and hence require a connection with a first bandwidth. Images encoded in the second format require to be sent across a network with a second bit rate larger than the first bit rate. The image data can be from still images such as scanned images (e.g. MRI, CT Scan images) or from videos.

In a third aspect of the invention, a display system, e.g. a digital electronic system is provided for displaying image data comprises (a) at least one input source encoding images to be displayed in a first format (e.g. with a first resolution) and in a second format (e.g. with a second resolution higher than the first); (b) a first display for displaying images encoded in the first format (e.g. with the first resolution) and a second display for displaying images encoded in the second format (e.g. with the second resolution); (c) a shared resource network linking the at least one input source with the first and second displays; wherein the images encoded in the first format (e.g. with the first resolution) are sent over the shared resource network through a first cable and wherein a first part of each image encoded in the second format (e.g. with the second resolution) is sent over the shared resource network through the first cable and a second part of each image encoded in the second format (e.g. with the second resolution) is sent over the shared resource network through a second cable. Images encoded in the first format can have a first resolution, a first frame rate and a first number of bits per pixel. Images encoded in the second format can have a second resolution, a second frame rate and a second number of bits per pixel. The product value given by the product of the second resolution, the second frame rate and the second number of bits per pixel is higher than the product value of the first format, given by the product of the first resolution, the first frame rate and the
first number of bits per pixel. Images encoded in the first format require to be sent across a network with a first bit rate and hence require a connection with a first bandwidth. Images encoded in the second format require to be sent across a network with a second bit rate larger than the first bit rate. The image data can be from still images such as scanned images (e.g. MRI, CTScan images) or from videos.

Sending the image data in the format having a lower resolution, e.g. image data having the product of the resolution, the frame rate and the number of bits per pixel or a bit rate with a lower product value (which format usually corresponds to an older format) over a single link can be advantageous when the decoder corresponding to a display for displaying images encoded with the first format, e.g. with the lower resolution or having the lower product value of the resolution, the frame rate and the number of bits per pixel or the lower bit rate, is not able to deal with multilink transmissions.

The images mentioned in any of the three aspects are preferably sent without being compressed. This means that the feature "part of each image encoded in the second format" refers to a part of the uncompressed image which is to be transferred. Use of uncompressed image data (sometimes called raw image data) has the advantage that there is no need to demonstrate that the compression/decompression procedures do not introduce errors into the images which is important for medical images especially those for diagnosis.

Sending the image data encoded with the first format, e.g. in the lower resolution (which usually corresponds to an older format) or having the lower bit rate over a single link can be advantageous when the receiving decoder corresponding to a lower resolution display is not able to deal with multilink transmissions. Such image data can have the product value given by the product of the resolution, the frame rate and the number of bits per pixel which is a lower value compared to product values for images encoded in the second format.

In a further aspect of the invention, the first format is a legacy format such as an HD format and the first resolution is a legacy resolution such as 2MP. The product value for the first format (i.e. the product of the first resolution, the first frame rate and the first number of bits per pixel) can be the product of resolution, the frame rate and the number of bits per pixel or the bit rate of a legacy format such as 2MP.

In a further aspect of the invention, the second format can be an upgraded or new format
such as a 4K format. In such a case the second resolution is an upgraded resolution
such as 8MP. For example, the product value of the resolution, the frame rate and the
number of bits per pixel for images encoded in the second format can be a product value
of the updated or new format such as 8MP.

In a further aspect of the invention, the first and second cables can be 10GE cables.

In a further aspect of the invention, a first fraction, e.g. 3/8 of each image in the second
format such as the 4K format and the images in the first format such as HD images are
sent through the first bandwidth limited link such as the first cable and a second fraction
such as 5/8 of each image encoded in the second format such as the 4K format are sent
through the second bandwidth limited link such as the second cable. The first and second
fractions add up to 1.

It is an advantage of this aspect of the invention that only two data cables such as 10GE
cables are required to stream video data encoded in the first and second formats such as
HD and 4K formats in parallel.

In a further aspect of the invention, the images encoded in the second format such as the
4K format are divided in a left part and a right part. The left part of each image contains a
first fraction such as 3/8 of the pixels of that image and the right part of each image
represents the remaining second fraction such as 5/8 of that image. The entire image is
reconstructed by displaying the left part and the right part of each image next to each
other on a second display at the same time.

It is an advantage of that aspect of the invention that when video images are sent in
parallel encoded in the first and second formats (e.g. in the first and second resolutions
or images encoded in the first format having a first resolution, a first frame rate and a first
number of bits per pixel (e.g. requiring a first bit rate to be transmitted over a network) and
images encoded in the second format have a second resolution, a second frame rate and
a second number of bits per pixel (e.g. normally requiring a second bit rate to be
transmitted over a network higher than the first bit rate), the first and second cable will
handle approximately the same bit rate. The risk of exceeding the bandwidth of one of the
cable is thereby reduced. In a further aspect of the present invention, a first fraction such
as 3/8 of each image encoded in the second format such as the 4K format is sent as a
first stream over the network and the remaining second fraction such as 5/8 of each image
encoded in the second format such as the 4K format is sent as a second stream over the
In accordance with an aspect of the present invention the network stream of the images encoded in the second format e.g. images having the second resolution, the second frame rate and the second number of bits per pixel (e.g. requiring a second bit rate to be transmitted over a network), such as a higher resolution 4K network stream is split into 2 different streams with different addresses. This means that the entire video images encoded with the second format such as the entire higher resolution video 4K video will not be sent as one stream. It is an advantage that the encoders and decoders do not need special configurations on the switch ports. A further advantage is that switches can be used having a limitation on the ports that can be configured for link bonding usage.

Standard Ethernet switches use address hashing to determine which link a packet has to be sent on. Packets of the same stream have different addresses so that the data of this stream is split on the 2 network connections, thus preventing a bandwidth overflow.

Whereas some switches such as Ethernet switches can be configured to use round robin load distribution for link aggregation, this has the disadvantage that packets will arrive out-of-order whereas embodiments of the present invention can have the advantage that they do not exhibit this problem.

The decoding engines which can be used with embodiments of the present invention are capable of processing a data stream of, for example, 10Gb/s independently of each other, leading to a more scalable solution.

However embodiments of the present invention are not limited to 10Gb/s cable. In a further embodiment of the present invention, a cable with a higher capacity of bits per second can be used such as 40G cabling instead of 10G cabling and this cabling can support a number of resolutions such as 8K, 4K and HD resolutions at a time when one of these formats such as 8K has become a legacy resolution.

In embodiments of the present invention, on the first cable, a first fraction of an image encoded in the second format such as an 8K image is sent, e.g. 4/6 of an 8K image, whereas on the second cable the remainder of the image encoded in the second format such as the 8K format (e.g. the fraction 2/6) as well as 5/8 and 3/8 of an image encoded in the first format such as a 4K image (to allow for support on legacy 4K decoders). Other formats such as HD could also be supported (for support on legacy HD decoders).
In a further embodiment, a 12 MP (megapixel) source is distributed on three 10G cable connections. This is done as follows:

First cable - a first fraction, e.g. 5/12 of 12MP is sent.
Second cable - a second fraction, e.g. 5/12 of 12MP is sent.

In another aspect the present invention provides, an encoding engine for encoding images from at least one input source, the images having a first format (e.g. with a first resolution) and in a second format (e.g. with a second resolution higher than the first); the encoding engine having means (e.g. a transmitter such as part of a network interface) for sending images encoded in the first format (e.g. with the first resolution) over a shared resource network through a first limited bandwidth link such as a first cable and for means for encoding (e.g. an encoder such as part of a network interface configured to encode) a first part of each image having the second format (e.g. with the second resolution) for sending over the shared resource network through the first limited bandwidth link such as the first cable and a second part of each image encoded in the second format (e.g. with the second resolution) for sending over the shared resource network through a second limited bandwidth link such as a second cable. Images encoded in the first format can have a first resolution, a first frame rate and a first number of bits per pixel (and requiring a first bit rate to be transmitted over a network). Images encoded in the second format can have a second resolution, a second frame rate and a second number of bits per pixel (and requiring a second bit rate to be transmitted over a network). The product of the second resolution, the second frame rate and the second number of bits per pixel has a higher value than the value of the product of the first resolution, the first frame rate and the first number of bits per pixel. The first bite rate can be lower than the second bit rate. The image data can be from still images such as scanned images (e.g. MRI, CT scan images) or from videos. The encoding engine can be embedded in an encoder or could be embedded in other apparatus for example in a camera that is the source of the images.

In another aspect the present invention provides, a decoding engine for decoding images received from at least one input source, the images having a first format (e.g. with a first resolution) and in a second format (e.g. with a second resolution higher than the first); the decoding engine having means for decoding (e.g. a decoder such as part of a network interface configured to decode) received images encoded in the first format (e.g. with the first resolution) being received over a shared resource network through a first limited bandwidth link such as a first cable and means for decoding (e.g. a decoder such as part
of a network interface configured to decode) a first part of each received image having the second format (e.g. with the second resolution) sent over the shared resource network through the first limited bandwidth link such as the first cable and means for decoding (e.g. a decoder such as part of a network interface configured to decode) a second part of each received image encoded in the second format with the second resolution sent over the shared resource network through a second limited bandwidth link such as a second cable. Images encoded in the first format can have a first resolution, a first frame rate and a first number of bits per pixel. Images encoded in the second format can have a second resolution, a second frame rate and a second number of bits per pixel. The product of the second resolution, the second frame rate and the second number of bits per pixel has a value higher than the product of the first resolution, the first frame rate and the first number of bits per pixel. Images encoded with the first format require a first bit rate to be transmitted over a network, and images encoded with the second format require a second bit rate to be transmitted over a network, the second bit rate being higher than the first bit rate. The image data can be from still images such as scanned images (e.g. MRI, CTScan images) or from videos.

The decoding engine can be embedded in a decoder or could be embedded in other apparatus for example in a display that is configured to display the two images with different resolutions.

In another aspect of the present invention a computer program product is provided comprising software which when executed on a processing engine is adapted to encode and send images encoded in the first format (e.g. with the first resolution) over a shared resource network through a first limited bandwidth link such as a first cable and to encode a first part of each image having the second format (e.g. with the second resolution) for sending over the shared resource network through the first limited bandwidth link such as the first cable and a second part of each image encoded in the second format (e.g. with the second resolution) for sending over the shared resource network through a second limited bandwidth link such as a second cable. Images encoded in the first format can have a first resolution, a first frame rate and a first number of bits per pixel. Images encoded in the second format can have a second resolution, a second frame rate and a second number of bits per pixel. The product of the second resolution, the second frame rate and the second number of bits per pixel has a value higher than the product of the first resolution, the first frame rate and the first number of bits per pixel. Images encoded with the first format require a first bit rate to be transmitted over a network, and images encoded with the second format require a
second bit rate to be transmitted over a network, the second bit rate being higher than
the first bit rate. The image data can be from still images such as scanned images (e.g.
MRI, CTScan images) or from videos.

In another aspect of the present invention, a computer program product is provided
comprising software which when executed on a processing engine is adapted, to decode
received images encoded in the first format (e.g. with the first resolution) over a shared
resource network through a first limited bandwidth link such as a first cable and to decode
a first part of each received image having the second format (e.g. with the second
resolution) received over the shared resource network through the first limited bandwidth
link such as the first cable and to decode a second part of each received image encoded
in the second format (e.g. with the second resolution received over the shared resource
network through a second limited bandwidth link such as a second cable. Images encoded
in the first format can have a first resolution, a first frame rate and a first number of bits
per pixel. Images encoded in the second format can have a second resolution, a second
frame rate and a second number of bits per pixel. The product of the second resolution,
the second frame rate and the second number of bits per pixel has a value higher than
the product of the first resolution, the first frame rate and the first number of bits per pixel.
Images encoded with the first format require a first bit rate to be transmitted over a
network, and images encoded with the second format require a second bit rate to be
transmitted over a network, the second bit rate being higher than the first bit rate. The
image data can be from still images such as scanned images (e.g. MRI, CTScan images)
or from videos.

The software mentioned above can be stored on a non-transitory signal storage medium,
such as an optical disk (CD-ROM or DVD-ROM); a magnetic tape, a magnetic disk, a
ROM, or a solid state memory such as a USB flash memory or similar.

**Brief Description of the drawings**

Fig. 1 shows a known video network display system.
Fig. 2 shows another known video network display system
Fig. 3 shows a video network in accordance with an embodiment of the present invention.
Fig. 3 shows a video network in accordance with another embodiment of the present
invention.
Fig. 4 shows the format of data packets generated by an encoder in accordance with
another embodiment of the present invention.
Fig. 5 shows a right part and a left part of an image are encoded in accordance with another embodiment of the present invention.

**Definitions**

"Uncompressed video" is digital video used by video cameras, video recording devices (including general purpose computers), and in video processors. It can be conveyed over various types of baseband digital video interfaces, such as HDMI, DVI, DisplayPort and SDI.

A "format" as used in this application refers to an encoding for images (still images and video) which defines important aspects of such images, like resolution, frame rate and a number of bits per pixel, which, in combination, contribute to the bit rate when these images are sent over a network.

An aspect of the present invention relates to digital interfaces for uncompressed image data, e.g. for commercial or consumer electronics devices such as digital televisions (DTVs), digital cable, satellite or terrestrial set-top boxes (STBs), and related peripheral devices including, but not limited to DVD players/recorders, and other related source or sink devices, such as personal computers with video display units.

For example protocols, requirements, and recommendations are defined including video formats and waveforms; colorimetry and quantization; transport of compressed and uncompressed, as well as Linear Pulse Code Modulation (LPCM), audio; carriage of auxiliary data; and implementations of the Video Electronics Standards Association (VESA) Enhanced Extended Display Identification Data Standard (E-EDID), which is used by sink devices to declare display capabilities and characteristics.

Formats can be for example, those defined in CEA Standard "A DTV Profile for Uncompressed High Speed Digital Interfaces", published by CONSUMER ELECTRONICS ASSOCIATION, July 2006 Technology & Standards Department 2500 Wilson Boulevard Arlington, VA 22201, USA, incorporated herein in its entirety.

Formats are disclosed below by resolution and field (same as frame rate) rate (and optionally by Picture Aspect Ratio (H:V). A video format should be defined such that when it is received at a monitor, the monitor has enough information to properly display the video to the user. A definition of a format can include, for example, in addition a video format timing, the Picture Aspect Ratio, Colorimetry Space, and Quantization levels as well as audio data.

1 640x480p 59.94Hz/60Hz 4:3 1:1
2 720x480p 59.94Hz/60Hz  4:3 8:9
3 720x480p 59.94Hz/60Hz  16:9 32:27
4 1280x720p 59.94Hz/60Hz  16:9 1:1
5 1920x1080i 59.94Hz/60Hz  16:9 1:1
6 720(1440)x480i 59.94Hz/60Hz  4:3 8:9
7 720(1440)x480i 59.94Hz/60Hz  16:9 32:27
8 720(1440)x240p 59.94Hz/60Hz  4:3 4:9
9 720(1440)x240p 59.94Hz/60Hz  16:9 16:27
10 2880x480i  59.94Hz/60Hz  4:3 2:9 - 20:93
11 2880x480i 59.94Hz/60Hz  16:9 8:27 - 80:27
12 2880x240p 59.94Hz/60Hz  4:3 1:9 - 10:9
13 2880x240p 59.94Hz/60Hz  16:9 4:27 - 40:27
14 1440x480p 59.94Hz/60Hz  4:3 4:9
15 1440x480p 59.94Hz/60Hz  16:9 16:27
16 1920x1080p 59.94Hz/60Hz  16:9 1:1
17 720x576p 50Hz 4:3 16:15
18 720x576p 50Hz  16:9 64:45
19 1280x720p 50Hz 16:9 1:1
20 1920x1080i 50Hz 16:9 1:1
21 720(1440)x576i 50Hz 4:3 16:15
22 720(1440)x576i 50Hz 16:9 64:45
23 720(1440)x288p 50Hz 4:3 8:1 5
24 720(1440)x288p 50Hz 16:9 32:45
25 2880x576i 50Hz 4:3 2:1 5 - 20:1 5
26 2880x576i 50Hz 16:9 16:45-160:45
27 2880x288p 50Hz 4:3 1:15 - 10:15
28 2880x288p 50Hz 16:9 8:45 - 80:45
29 1440x576p 50Hz 4:3 8:15
30 1440x576p 50Hz 16:9 32:45
31 1920x1080p 50Hz 16:9 1:1
32 1920x1080p 23.97Hz/24Hz 16:9 1:1
33 1920x1080p 25Hz 16:9 1:1
34 1920x1080p 29.97Hz/30Hz 16:9 1:1
35 2880x480p 59.94Hz/60Hz 4:3 2:9
36 2880x480p 59.94Hz/60Hz 16:9 8:27
37 2880x576p 50Hz 4:3 4:15
38 2880x576p 50Hz 16:9 16:45
39 1920x1080i (1250 total) 50Hz 16:9 1:1
40 1920x1080i 100Hz 16:9 1:1
41 1280x720p 100Hz 16:9 1:1
42 720x576p 100Hz 4:3 16:15
43 720x576p 100Hz 16:9 64:45
44 720(1440)x576i 100Hz 4:3 16:15
45 720(1440)x576i 100Hz 16:9 64:45
46 1920x1080i 119.88/120Hz 16:9 1:1
47 1280x720p 119.88/120Hz 16:9 1:1
48 720x480p 119.88/120Hz 4:3 8:9
49 720x480p 119.88/120Hz 16:9 32:27
Common high-definition video modes are shown below in a list (High-definition video: source Wikipedia):

<table>
<thead>
<tr>
<th>Frame size in pixels (WxH)</th>
<th>Pixels per image (i.e. the resolution)</th>
<th>Scanning type</th>
<th>Frame rate(s) (Hz)</th>
</tr>
</thead>
<tbody>
<tr>
<td>720p</td>
<td>1,280x720</td>
<td>Progressive</td>
<td>23.976, 24, 25, 29.97, 30, 50, 59.94, 60, 72</td>
</tr>
<tr>
<td>1080i</td>
<td>1,920x1,080</td>
<td>Interlaced</td>
<td>25 (50 fields/s), 29.97 (59.94 fields/s), 30 (60 fields/s)</td>
</tr>
<tr>
<td>1080p</td>
<td>1,920x1,080</td>
<td>Progressive</td>
<td>24 (23.976), 25, 30 (29.97), 50, 60 (59.94)</td>
</tr>
<tr>
<td>1440p</td>
<td>2,560x1,440</td>
<td>Progressive</td>
<td>24 (23.976), 25, 30 (29.97), 50, 60 (59.94)</td>
</tr>
<tr>
<td>2000</td>
<td>2,048x1,536</td>
<td>Progressive</td>
<td>24</td>
</tr>
<tr>
<td>2160p (also known as 4k)</td>
<td>3,840x2,160</td>
<td>Progressive</td>
<td>60, 120</td>
</tr>
<tr>
<td>2540p</td>
<td>4,520x2,540</td>
<td>Progressive</td>
<td>11,480,800</td>
</tr>
<tr>
<td>4000p</td>
<td>4,096x3,072</td>
<td>Progressive</td>
<td>12,582,912</td>
</tr>
<tr>
<td>4320p (also known as 8k)</td>
<td>7,680x4,320</td>
<td>Progressive</td>
<td>60, 120</td>
</tr>
</tbody>
</table>

60 as well as those formats reserved for the future.
"Resolution" refers to the number of pixels in a display. A digital image file has a resolution which is the number of pixels that are used for the display of the image.

"Bit rate", sometimes written bitrate or bit-rate, is the number of bits defined in images that are conveyed or processed per unit of time in a network. In accordance with embodiments of the present invention some or all of the images are transmitted without compression and optionally without encryption so that a minimum of processing is required to display the images. The product of resolution, frame rate and bits per pixel of images encoded by a format gives a value of bits per unit time which bit rate contributes in a significant part to the bandwidth required to transmit the images. Additional bits may be required for headers, error correction, padding etc. Images encoded with different formats are transmitted with different bit rates.

"Bandwidth" is the bit rate of available or consumed information capacity related to images (still or video) expressed in bits per unit time transmitted or processed in a network or in an element of a network such as a cable. Typical bandwidth for different connection types are:

1.544 Mbit/s T1/DS1; 2.048 Mbit/s E1 / E-carrier; 4 Mbit/s ADSL1; 10 Mbit/s Ethernet; 11 Mbit/s Wireless 802.1 1b; 24 Mbit/s ADSL2+; 44.736 Mbit/s T3/DS3; 54 Mbit/s Wireless 802.11g; 100 Mbit/s Fast Ethernet; 155 Mbit/s OC3; 600 Mbit/s Wireless 802.11n; 622 Mbit/s OC12; 1 Gbit/s Gigabit Ethernet; 1.3 Gbit/s Wireless 802.11ac; 2.5 Gbit/s OC48; 5 Gbit/s USB 3.0; 9.6 Gbit/s OC192; 10 Gbit/s 10; Gigabit Ethernet, USB 3.1; 40 Gbit/s Thunderbolt 3; 100 Gbit/s 100 Gigabit Ethernet.

"Colour depth", also known as bit depth, as used in this application is the number of bits used to indicate the colour of a single pixel, e.g. in a bitmapped image or video frame buffer. Video standards, such as High Efficiency Video Coding (H.265), specify the number of bits used for each colour component, in which case the colour depth as used in this application is the total number of bits required for all colour components, i.e. colour depth refers to the number of bits per pixel required to define the colour of each pixel (rather than bits per component, bits per channel, bits per colour, or similar, etc). Typical values are 24-, 30-, 36- and 48-bits per pixel.

"Legacy" as used in this application refers to an old format, method, technology, computer system, or application program, relating to being, or being outdated. Being a legacy format generally means that existing decoders and displays will be able to display images encoded with the legacy format.
"Product value" refers to the product of resolution, frame rate and a number of bits per pixel of images encoded with a first or second format. The product value relates to a bit rate which contributes largely to the overall bit rate required to transmit the pages over a network.

Description of the preferred embodiments.

The present invention will be described with respect to particular embodiments and with reference to certain drawings but the invention is not limited thereto but only by the claims. The drawings described are only schematic and are non-limiting.

Furthermore, the terms first, second, third and the like in the description and in the claims, are used for distinguishing between similar elements and not necessarily for describing a sequential or chronological order. The terms are interchangeable under appropriate circumstances and the embodiments of the invention can operate in other sequences than described or illustrated herein.

Moreover, the terms top, bottom, over, under and the like in the description and the claims are used for descriptive purposes and not necessarily for describing relative positions. The terms so used are interchangeable under appropriate circumstances and the embodiments of the invention described herein can operate in other orientations than described or illustrated herein. The term "comprising", used in the claims, should not be interpreted as being restricted to the means listed thereafter; it does not exclude other elements or steps. It needs to be interpreted as specifying the presence of the stated features, integers, steps or components as referred to, but does not preclude the presence or addition of one or more other features, integers, steps or components, or groups thereof. Thus, the scope of the expression "a device comprising means A and B" should not be limited to devices consisting only of components A and B. It means that with respect to the present invention, the only relevant components of the device are A and B. Similarly, it is to be noticed that the term "coupled", also used in the description or claims, should not be interpreted as being restricted to direct connections only. Thus, the scope of the expression "a device A coupled to a device B" should not be limited to devices or systems wherein an output of device A is directly connected to an input of device B. It means that there exists a path between an output of A and an input of B which may be a path including other devices or means.

Elements or parts of the described devices may comprise logic encoded in media for
performing any kind of information processing. Logic may comprise software encoded in a disk or other computer-readable medium and/or instructions encoded in an application specific integrated circuit (ASIC), field programmable gate array (FPGA), or other processor or hardware.

References to software can encompass any type of programs in any language executable directly or indirectly by a processor.

References to logic, hardware, processor or circuitry can encompass any kind of logic or analog circuitry, integrated to any degree, and not limited to general purpose processors, digital signal processors, ASICs, FPGAs, discrete components or transistor logic gates and so on.

An example of an embodiment of the present invention can be seen on figure 3 that shows how an existing networked display system can be upgraded from legacy displays and image sources such as cameras or optical disks configured to display or generate images encoded in a first format, (e.g. with a first resolution), to include upgraded displays and image sources such as cameras or optical disks, the displays being capable of displaying or generating images encoded in a second format, (e.g. with a second resolution typically being a higher resolution than images encoded in the first format) such as 4k displays and cameras or optical disks. Images encoded in the first format can have a first resolution, a first frame rate and a first number of bits per pixel. Images encoded in the second format can have a second resolution, a second frame rate and a second number of bits per pixel. The product of the second resolution, the second frame rate and the second number of bits per pixel has a higher value than the product of the first resolution, the first frame rate and the first number of bits per pixel. Images encoded with the first format require a first bit rate to be transmitted over a network, and images encoded with the second format require a second bit rate to be transmitted over a network, the second bit rate being higher than the first bit rate. The image data can be from still images such as scanned images (e.g. MRI, CTScan images) or from videos.

An image source such as camera 2 generating images encoded in a first format such as images with a resolution of 2MP (Million Pixels) at a rate of 30 to 60 frames per second or other image sources such as stored images on optical disks that store images with a resolution of 2MP (Million Pixels) that can be streamed at a rate of 30 to 60 frames per second and e.g. one of the typical bits per pixel such as 24-, 30-, 36- and 48-bits per pixel, is/are connected to an AV to IP encoder 3.
The AV-to-IP encoder 3 (like e.g. the MNA-120 from Barco N.V. Belgium) takes in baseband video data and converts that video data without compression to an IP stream for transportation over a standard high but limited bandwidth IP network 1. The encoder is connected to the network 1 by means of a first limited bandwidth link such as a first cable 13 of a sufficient bandwidth to allow the streaming of images encoded in the first format, e.g. with the first bit rate or first resolution such as a resolution of 2MP at a rate of 30 to 60 frames per second and e.g. one of the typical bits per pixel such as 24-, 30-, 36- and 48-bits per pixel. The first limited bandwidth link such as cable 13 is for instance a 10 GE (Gigabit Ethernet) cable. Each image consists of N1 lines, each line being formed by M1 pixels. For an image with 1920 000 pixels, for instance N1 can be equal to 1200 and M1 can be equal to 1600. The data packets generated by the encoder typically have a format as shown on figure 4.

A second image source such as a camera 10 generating images with a resolution of 8MP (Million Pixels) at a rate of 30 to 60 frames per second and e.g. one of the typical bits per pixel such as 24-, 30-, 36- and 48-bits per pixel or another image source such as stored images on an optical disk with a resolution of 8MP (Million Pixels) that can be streamed at a rate of 30 to 60 frames per second and e.g. one of the typical bits per pixel such as 24-, 30-, 36- and 48-bits per pixel is connected to an AV-to-IP encoder 11.

The AV-to-IP encoder 11 takes in baseband video data and converts that video data without compression to suitable packets such as TCP/IP compliant data packets to be sent over the network 1. In addition, the AV-to-IP encoder 11 optionally converts the same video data to a downscaled video data such as video data with a lower bit rate or having the first resolution, i.e. a lower resolution, in this case 2MP and e.g. with a lower number of bits required for the resolution, frame rate and number of bits per pixel, and converts the downscaled video data to packets such as TCP/IP compliant data packets to be sent over the network 1. The data packets generated by the encoder typically have a format as shown on figure 4.

The AV-to-IP encoder 11 is connected to the network 1 by means of two second and third limited bandwidth links such as second and third cables 14 and 15 of sufficient bandwidth to allow the streaming of images encoded in a first and a second format, e.g. requiring the first and second bit rate for example resolutions of 8MP and 2MP (e.g. two different bit rates) in parallel at a rate of 30 to 60 fps and one of the typical bits per pixel such as 24-, 30-, 36- and 48-bits per pixel. The network 1 can be a single unified network or can
comprise different links of which two links are the cables 14 and 15. Other links within the network may be wireless links, point-point microwave links or similar provided they have the required bandwidth. These other links will generally be transparent.

The inventor discovered that it was possible to send uncompressed video data at two different formats, e.g. two different bit rates or two different resolutions (2MP and 8MP), or two different resolutions, frame rates and numbers of bits per pixel, in parallel over two limited bandwidth links such as two cables without adding excessive lag between image capture and display of that image, thereby allowing the upgrade of existing networked display systems originally conceived for the streaming of video images encoded in the first format, e.g. with a legacy (e.g. lower) bit rate for example with a resolution of 2MP at a rate of 30 to 60 fps and one of the typical bits per pixel such as 24-, 30-, 36- and 48-bits per pixel.

The data packets encoding the downscaled images encoded in a first format, e.g. requiring a first bit rate to be sent over a network or with a first resolution, e.g. the resolution of 2MP or a first resolution, frame rate and numbers of bits per pixel are sent on a single link through the second cable 14.

The data packets encoding the images encoded in a second format e.g. requiring a second bit rate to be sent over a network or with a second resolution such as a resolution of 8MP (e.g. resolution: 8MP, frame rate 30-60 fps and one of the typical bits per pixel such as 24-, 30-, 36- and 48-bits per pixel) are sent over two links. A certain first fraction, e.g. three eighth of the data packets encoding the second resolution images such as the "4K" images (e.g. images encoded in the second format requiring a second bit rate for transmission over a network) are sent over the second bandwidth limited link such as the second cable 14; and the remaining fraction such as five eighth of the data packets encoding the second resolution images such as the 4K images (e.g. images encoded in the second format and requiring the second bit rate for transmission over a network) are sent over the third cable 15. This is done with e.g. a dual link connection between the encoder 11 and a receiver connected through the network 1. The sum of the fractions is "1".

Each image encoded with the second format, e.g. with a resolution of 8MP consists of N2 lines, each line being formed by M2 pixels. For an image with 8,847,360 pixels, we can have for instance N2 = 2160 and M2 = 4096.
In a particular embodiment of the present invention, each data packet sent over the second limited bandwidth link such as the second cable 14 contains information over the first fraction such as 3/8 x M2 pixels of two successive lines and each data packet sent over the third limited bandwidth link such as the third cable 15 contains information over the second fraction or last 5/8 X M2 pixels. This is advantageous when images with 2MP and 8MP are streamed in parallel by the same encoder 11. In that case, both cables will carry 5MP. This corresponds with a bit rate of 5MP x 60 frames per second x 24 bit per pixel = 7.2Gb/s.

Each cable can thus deal with additional data packets (e.g. metadata, command signals ...) without risk of being saturated.

Another advantage of that particular distribution of the data packets is that an "old" or legacy IP-to-AV decoder 6 like e.g. the MNA-DEC 120 from Barco N.V. Belgium is not able to deal with multiple streams. In other words, some legacy decoders are not able to reconstruct the video images correctly (if at all) if the data packets encoding those video signals are sent over multiple links. To avoid that problem, it is thus advantageous to send the data packets encoding the video signals in the older (legacy low resolution) format over a single link.

In this particular embodiment, the data packets sent over the second limited bandwidth link such as the second cable 14 encode a left part of an image while the data packets sent over the third limited bandwidth link such as the third cable 15 encode a right part of an image as shown on figure 5.

The data packets sent over the first cable and first link contain information over the first 3/8 * M2 pixels of each of the N2 lines. The data packets sent over the second cable and second link contain information on the last 5/8 * M2 pixels of each of the N2 lines. The data packets are for instance formatted according to the RFC 4175 scheme. In that scheme, each line segment is characterized by its length, the line number of the line it belongs to and an offset. The offset specifies where on the line the segment starts.

Table 1 gives an overview of the parameters used to packetize the image data in the first link and the second link in accordance with an embodiment of the present invention.

Link 1 is characterized by a first IP address A. Link 2 is characterized by a second IP address B.
The timestamp and SSRC field are identical for the two streams and are calculated as described in the RFC4175. Sequence numbering of the RTP packets is done individually on the two streams. As the two streams can follow different paths on the network, there can be a large amount of reordering of packets between the two streams, while the amount of reordering within the same stream is limited (usually none). Both sides of the video can now be decoded independently.

In a network stream compliant to RFC4175, the offset of the first packet of a scan line is usually zero. In case the video is split into two streams, the width of the left stream is added to each of the offsets of the right stream. This has the advantage that the right stream can be decoded independently of the left stream.

The last packet of a particular stream is indicated with a marker bit. A decoder receiving video which is split into two streams has to wait for both markers to conclude the entire video frame is received.

As a summary this is how a decoding engine (see below for further details) can work in accordance with an embodiment of the present invention:

- Receive both the left side and the right side image streams.
- Process both streams, optionally independent from each other, for example both decoder engines share a video memory buffer which is large enough for the entire video.
- When both the left stream and the right stream have received a marker, the entire video frame is complete. The decoder engine processing the left stream has now filled the shared video memory buffer at the left side; the decoder engine processing the right stream has filled the shared video memory buffer at the right side.

**Further embodiment with higher resolutions**

The present invention is in general applicable to all kinds of problems relating to the streaming of images with different resolutions, such as HD, UHD, 4K, 8K etc. (e.g. with different formats or different combinations of resolution, frame rate and number of bits per pixel i.e. requiring different bit rates to be sent over a network).

For example, the present invention is not limited to specific formats such as images with 4K and HD resolutions.
More generally, there is often a need to send higher resolution images, e.g. images requiring a high or higher bandwidth or bit rate or having a high or higher combination of resolution, a frame rate and number of bits per pixel) over a network that is configured to generate, transmit and display lower resolution legacy images, images requiring a low or lower bandwidth or bit rate or having a lower combination of resolution, a frame rate and number of bits per pixel).

A further embodiment of the present invention for example, uses 40G cabling instead of 10G cabling and can support images requiring a bit rate for transmission or having a combination of resolution, a frame rate and number of bits per pixel) e.g. such images with 8K, 4K and HD resolution at a time when 8K has become a legacy resolution.

On the first cable, a first fraction of an image encoded with one format such as an 8K image is sent, e.g. 4/6 of an 8K image, whereas on the second cable the remainder of the 8K (e.g. the fraction 2/6) as well as 5/8 and 3/8 of images with a lower resolution or with a lower combination of having a lower combination of resolution, a frame rate and number of bits per pixel or requiring a lower bit rate) such as 4K images (to allow for support on legacy 4K decoders). Other formats such as HD could also be supported (for support on legacy HD decoders).

In a further embodiment, images from a 12 MP (megapixel) source at e.g. a rate of 30 to 60 frames per second and one of the typical bits per pixel such as 24-, 30-, 36- and 48-bits per pixel are distributed on three 10G cable connections. This is done as follows:

First cable - a first fraction, e.g. 5/12 of 12MP is sent.
Second cable - a second fraction e.g. 5/12 of 12MP is sent.
Third cable - the balance e.g. 2/12 of 12MP + downsampled 3MP is sent.

This further embodiment would be applicable in a radiology oriented environment for example.

Further embodiments - encoder and decoder

In accordance with an embodiment of the present invention, an encoding engine is provided for encoding images from at least one input source. The encoding engine can include one or more microprocessors, processors, controllers, or a central processing unit (CPU) and/or a Graphics Processing Unit (GPU), and can be adapted to carry out functions by being programmed with software, i.e. one or more computer programmes.
The encoding engine may have memory (such as non-transitory computer readable medium, RAM and/or ROM), an operating system running on a microprocessor, optionally a display such as a fixed format display, data entry devices such as a keyboard, a pointer device such as a "mouse", serial or parallel ports such as I/O ports to communicate with other devices, or network cards and connections to connect to any of the networks or to peripheral devices. The encoding engine may be embedded in another device such as a camera or may be a stand-alone device.

The images encoded by the encoding engine have a first format (e.g. with a first resolution) and in a second format (e.g. with a second resolution higher than the first); the encoding engine having means for sending images encoded in the first format (e.g. with the first resolution) over a shared resource network through a first limited bandwidth link such as a first cable and for means for encoding (e.g. an encoder such as part of a network interface for encoding) a first part of each image having the second format (e.g. with the second resolution) for sending over the shared resource network through the first limited bandwidth link such as the first cable and a second part of each image encoded in the second format (e.g. with the second resolution) for sending over the shared resource network through a second limited bandwidth link such as a second cable. Images encoded in the first format can have a first resolution, a first frame rate and a first number of bits per pixel. Images encoded in the second format can have a second resolution, a second frame rate and a second number of bits per pixel. The product of the second resolution, the second frame rate and the second number of bits per pixel has a higher value than the product of the first resolution, the first frame rate and the first number of bits per pixel. Images encoded in the first format require to be sent across a network with a first bit rate and hence require a connection with a first bandwidth. Images encoded in the second format require to be sent across a network with a second bit rate larger than the first bit rate. The image data can be from still images such as scanned images (e.g. MRI, CTScan images) or from videos.

The first format can be a legacy format and the first resolution can be a legacy resolution, e.g. a legacy combination of resolution, frame rate and bits per pixel or a legacy bit rate. For example, the first format can be an HD format and the first resolution can be 2MP e.g. at a rate of 30 to 60 frames per second and one of the typical bits per pixel such as 24-, 30-, 36- and 48-bits per pixel. The second format can be an upgraded format and the second resolution can be an upgraded resolution, e.g. an upgraded combination of resolution, frame rate and bits per pixel or an upgraded bit rate. For example the second format can be 4K and the second resolution can be 8MP e.g. at a rate of 30 to 60 frames.
per second and one of the typical bits per pixel such as 24-, 30-, 36- and 48-bits per pixel. The first and second cables can be 10GE cables.

The encoding engine can be adapted to send a first fraction of each image in the second format and the images in the first format through the first bandwidth limited link and a second fraction of each image in the second format through the second bandwidth limited link, whereby the first and second fractions add up to 1. These images are not compressed. The first fraction can be 3/8 of each image in the second format and the second fraction can be 5/8 of each image in the second format.

The encoding engine is adapted for use with two 10GE cables being required to stream video data in the first and second formats whereby the first and second formats can be HD and 4K formats respectively.

The encoding engine can be adapted to separate the images encoded in the second format in a left part and a right part. The left part of each image can contain a first fraction such as 3/8 of the pixels of that image and the right part of each image represents the remaining second fraction such as 5/8 of that image. A first fraction of each image encoded in the second format can be sent as a first stream over the network and the remaining second fraction of each image encoded in the second format can be sent as a second stream over the network. The encoding engine can be adapted to send split video images in parallel encoded in the first and second formats respectively e.g. having the first and second resolutions or first and second combinations of resolution, frame rate and bits per pixel, and e.g. requiring first and second bit rates for the images to be transmitted over a network. A consequence of the splitting is that the first and second limited bandwidth links handle approximately the same bit rate.

In accordance with another embodiment of the present invention, a decoding engine is provided for decoding images from at least one input source. The decoding engine can include one or more microprocessors, processors, controllers, or a central processing unit (CPU) and/or a Graphics Processing Unit (GPU), and can be adapted to carry out functions by being programmed with software, i.e. one or more computer programmes.

The decoding engine may have memory (such as non-transitory computer readable medium, RAM and/or ROM), an operating system running on a microprocessor, optionally a display such as a fixed format display, data entry devices such as a keyboard, a pointer device such as a "mouse", serial or parallel ports such as I/O ports to communicate with
other devices, or network cards and connections to connect to any of the networks or to peripheral devices. The decoding engine may be embedded in another device such as a display or may be a stand-alone device.

The decoding engine is for decoding images received from at least one input source, whereby the images have a first format (e.g. with a first resolution or a first combination of resolution, frame rate and bits per pixel) and have a second format (e.g. with a second resolution higher than the first, such as a second combination of resolution, frame rate and bits per pixel; the decoding engine having means for decoding received images encoded in the first format (e.g. with the first resolution or the first combination of resolution, frame rate and bits per pixel) over a shared resource network through a first limited bandwidth link such as a first cable and means for decoding a first part of each received image having the second format (e.g. with the second resolution or the second combination of resolution, frame rate and bits per pixel) received over the shared resource network through the first limited bandwidth link such as the first cable and means for decoding a second part of each received image encoded in the second format (e.g. with the second resolution or the second combination of resolution, frame rate and bits per pixel) received over the shared resource network through a second limited bandwidth link such as a second cable.

The first format can be a legacy format and the first resolution can be a legacy resolution, and the first combination of resolution, frame rate and bits per pixel can be a legacy combination. The first format can be an HD format and the first resolution can be 2MP e.g. at a rate of 30 to 60 frames per second and one of the typical bits per pixel such as 24-, 30-, 36- and 48-bits per pixel. The second format can be an upgraded format and the second resolution can be an upgraded resolution and can be a second combination of resolution, frame rate and bits per pixel. The second format can be 4K and the second resolution can be 8MP e.g. at a rate of 30 to 60 frames per second and one of the typical bits per pixel such as 24-, 30-, 36- and 48-bits per pixel. The first and second cables can be 10GE cables. Two 10GE cables are required to stream video data in the first and second formats whereby the first and second formats can be HD and 4K formats respectively.

The decoding engine can be adapted to decode a first fraction of each image in the second format and the images in the first format received through the first bandwidth limited link and to decode a second fraction of each image in the second format received through the second bandwidth limited link, whereby the first and second fractions add up to 1. The
first fraction can be 3/8 of each image in the second format and the second fraction can be 5/8 of each image in the second format.

The decoding engine may be adapted to decode images encoded in the second format which are divided in a left part and a right part. The left part of each image can contain a first fraction such as 3/8 of the pixels of that image and the right part of each image can represent the remaining second fraction such as 5/8 of that image. A first fraction of each image encoded in the second format can be received as a first stream over the network and the remaining second fraction of each image encoded in the second format can be received as a second stream over the network. The decoding engine can be adapted to receive video images in parallel having the first and second formats such as the first and second resolutions or the first and second combinations of resolution, frame rate, and bits per pixel (and despite normally requiring first and second bit rates), and the first and second limited bandwidth links handling approximately the same bit rate.

The decoding engine can be adapted to reconstruct the entire image by displaying the left part and the right part next to each other on a second display.

In accordance with another embodiment of the present invention software may be implemented as a computer program product which has been compiled for a processing engine in the encoding or decoding engine described above. The computer program product may be stored on a non-transitory signal storage medium such as an optical disk (CD-ROM or DVD-ROM), a digital magnetic tape, a magnetic disk, a solid state memory such as a USB flash memory, a ROM, etc.

The encoding software can be embodied in a computer program product adapted to carry out the following functions when the software is loaded onto the respective device or devices and executed on one or more processing engines such as microprocessors, ASIC's, FPGA's etc.

The software for encoding can be adapted to encode images having a first format (e.g. with a first resolution or with a first combination of resolution, frame rate and bits per pixel) and in a second format with a second resolution higher than the first or a second combination of resolution, frame rate and bits per pixel requiring a larger bandwidth than the first combination.

The encoding software can be embodied in a computer program product adapted to carry
out the following functions when the software is loaded onto the respective device or devices and executed on one or more processing engines such as microprocessors, ASIC's, FPGA's etc.:

sending images encoded in the first format, (e.g. with the first resolution or with the first combination of resolution, frame rate and bits per pixel) over a shared resource network through a first limited bandwidth link such as a first cable and encoding a first part of each image having the second format (e.g. with the second resolution or the second combination of resolution, frame rate, and bits per pixel) sending over the shared resource network through the first limited bandwidth link such as the first cable and a second part of each image encoded in the second format (e.g. with the second resolution or with the second combination) for sending over the shared resource network through a second limited bandwidth link such as a second cable.

The first format can be a legacy format and the first resolution can be a legacy resolution and the first frame rate or bits per pixel can have legacy values. For example, the first format can be an HD format and the first resolution can be 2MP e.g. at a rate of 30 to 60 frames per second and one of the typical bits per pixel such as 24-, 30-, 36- and 48-bits per pixel. The second format can be an upgraded format and the second resolution can be an upgraded resolution and the second combination can be an upgraded combination.

For example the second format can be 4K and the second resolution can be 8MP e.g. at a rate of 30 to 60 frames per second and one of the typical bits per pixel such as 24-, 30, 36- and 48-bits per pixel. The first and second cables can be 10GE cables.

The encoding software can be embodied in a computer program product adapted to carry out the following functions when the software is loaded onto the respective device or devices and executed on one or more processing engines such as microprocessors, ASIC's, FPGA's etc.:

sending a first fraction of each image in the second format and the images in the first format through the first bandwidth limited link and a second fraction of each image in the second format through the second bandwidth limited link, whereby the first and second fractions add up to 1. These images are not compressed. The first fraction can be 3/8 of each image in the second format and the second fraction can be 5/8 of each image in the second format. The encoded images are sent via two 10GE cables which are required to stream video data in the first and second formats whereby the first and second formats can be HD and 4K formats respectively.
The encoding software can be embodied in a computer program product adapted to carry out the following functions when the software is loaded onto the respective device or devices and executed on one or more processing engines such as microprocessors, ASIC's, FPGA's etc.:

5 separating the images encoded in the second format in a left part and a right part. The left part of each image can contain a first fraction such as 3/8 of the pixels of that image and the right part of each image represents the remaining second fraction such as 5/8 of that image. A first fraction of each image encoded in the second format can be sent as a first stream over the network and the remaining second fraction of each image encoded in the second format can be sent as a second stream over the network.

The encoding software can be embodied in a computer program product adapted to carry out the following functions when the software is loaded onto the respective device or devices and executed on one or more processing engines such as microprocessors, ASIC's, FPGA's etc.:

10 Sending video images in parallel being encoded with first and second formats, e.g. having the first and second resolution or the first and second combinations of resolution, frame rate and bits per pixel, and the first and second limited bandwidth links handle approximately the same bit rate despite images encoded in the first format require to be sent across a network with a first bit rate and hence require a connection with a first bandwidth and images encoded in the second format normally require to be sent across a network with a second bit rate larger than the first bit rate.

The decoding software can be embodied in a computer program product adapted to carry out the following functions when the software is loaded onto the respective device or devices and executed on one or more processing engines such as microprocessors, ASIC's, FPGA's etc.:

15 The software for decoding images received from at least one input source, when executed on a processing engine, can decode the images having a first format (e.g. with a first resolution or a first combination of resolution, frame rate and bits per pixel) and having a second format (e.g. with a second resolution higher than the first or a second combination of resolution, frame rate or bits per pixel, the second combination requiring a larger bandwidth than the first combination; the decoding software being adapted, when executed on a processing engine, for decoding received images encoded in the first format (e.g. with the first resolution or the first combination of resolution, frame rate and bits per pixel) over a shared resource network through a first limited bandwidth link such
as a first cable and for decoding a first part of each received image having the second format (e.g. with the second resolution or with the second combination of resolution, frame rate and bits per pixel) received over the shared resource network through the first limited bandwidth link such as the first cable and for decoding a second part of each received image encoded in the second format (e.g. with the second resolution or the second combination) received over the shared resource network through a second limited bandwidth link such as a second cable.

The software for decoding can be adapted to decode, when executed on a processing engine, images having a first format with a first resolution and in a second format with a second resolution higher than the first.

The first format can be a legacy format and the first resolution can be a legacy resolution and the first combination can be a legacy combination or a legacy bit rate. The first format can be an HD format and the first resolution can be 2MP e.g. at a rate of 30 to 60 frames per second and one of the typical bits per pixel such as 24-, 30-, 36- and 48-bits per pixel. The second format can be an upgraded format and the second resolution can be an upgraded resolution and the second frame rates and bits per pixel can have upgraded values or upgraded bit rates. The second format can be 4K and the second resolution can be 8MP e.g. at a rate of 30 to 60 frames per second and one of the typical bits per pixel such as 24-, 30-, 36- and 48-bits per pixel. The first and second cables can be 10GE cables. Two 10GE cables are required to stream video data in the first and second formats whereby the first and second formats can be HD and 4K formats respectively.

The software for decoding can be adapted to decode, when executed on a processing engine, a first fraction of each image in the second format and the images in the first format received through the first bandwidth limited link and to decode a second fraction of each image in the second format received through the second bandwidth limited link, whereby the first and second fractions add up to 1. The first fraction can be 3/8 of each image in the second format and the second fraction can be 5/8 of each image in the second format.

The software for decoding can be adapted to decode images encoded in the second format, when executed on a processing engine, which are divided in a left part and a right part. The left part of each image can contain a first fraction such as 3/8 of the pixels of that image and the right part of each image can represent the remaining second fraction.
such as 5/8 of that image. A first fraction of each image encoded in the second format can be received as a first stream over the network and the remaining second fraction of each image encoded in the second format can be received as a second stream over the network.

The software for decoding can be adapted to reconstruct the entire image, when executed on a processing engine by displaying the left part and the right part next to each other on a second display.

The software for decoding can be adapted to receive video images encoded in the first and second formats in parallel, e.g. images having the first and second resolutions or the first and second combinations and despite requiring normally first or second bit rates for transmission over a network with the second bit rate being higher than the first bit rate, whereby the first and second limited bandwidth links handle approximately the same bit rate.

The software mentioned above can be stored on a non-transitory signal storage medium, such as an optical disk (CD-ROM or DVD-ROM); a magnetic tape, a magnetic disk, a ROM, or a solid state memory such as a USB flash memory or similar.
Claims.

1. A display system for displaying image data comprising at least one input source encoding images to be displayed in a first format with a first combination of resolution, frame rate and bits per pixel a product of these having a first product value and in a second format with a second combination of resolution, frame rate and bits per pixel whose product has a higher product value than the first; a first display for displaying images encoded in the first format with the first combination of resolution, frame rate and bits per pixel and a second display for displaying images encoded in the second format with the second combination of resolution, frame rate and bits per pixel; a shared resource network linking the at least one input source with the first and second displays; wherein the images encoded in the first format with the first combination of resolution, frame rate and bits per pixel are sent over the shared resource network through a first limited bandwidth link and wherein a first part of each image encoded in the second format with the second combination of resolution, frame rate and bits per pixel is sent over the shared resource network through the first limited bandwidth link and a second part of each image encoded in the second format with the second combination of resolution, frame rate and bits per pixel is sent over the shared resource network through a second limited bandwidth link.

2. The display system of claim 1 wherein the first limited bandwidth link and/or the second limited bandwidth link are cables.

3. The display system of claim 1 or 2, wherein the first format is selected from a legacy format and HD format, and the resolution is selected from a legacy resolution and a 2MP resolution.

4. The display system of any of the preceding claims, wherein, the second format is selected from an upgraded format and a 4K formation and the resolution is selected from an upgraded resolution and an 8MP resolution.

5. The display system of any of the claims 2 to 4, wherein the first and second cables are 10GE cables.

6. The display system of any preceding claim, wherein a first fraction of each image in the second format and the images in the first format are sent through the first
bandwidth limited link and a second fraction of each image in the second format are sent through the second bandwidth limited link, whereby the first and second fractions add up to 1.

7. The display system of any of the claims 2 to 6, wherein two 10GE cables are required to stream video data in the first and second formats whereby the first and second formats are HD and 4K formats respectively.

8. The display system of any preceding claim, wherein images encoded in the second format are divided in a left part and a right part.

9. The display system of claim 8, wherein the left part of each image contains a first fraction of the pixels of that image and the right part of each image represents the remaining second fraction of that image.

10. The display system according to claim 8 or 9, adapted to reconstruct the entire image by displaying the left part and the right part next to each other on a second display.

11. The display system of any preceding claim, wherein a first fraction of each image encoded in the second format is sent as a first stream over the network and the remaining second fraction of each image encoded in the second format is sent as a second stream over the network.

12. A method for displaying image data, the method comprising:

   at least one input source encoding images to be displayed in a first format with a first combination of resolution, frame rate and bits per pixel and the product of these having a first product value and in a second format with a second combination of resolution, frame rate and bits per pixel which has a product value higher than the first;

   displaying images with the first combination of resolution, frame rate and bit rate and images with the second combination of resolution, frame rate and bits per pixel on different displays; wherein the images encoded in the first format with the first combination of resolution, frame rate and bits per pixel are sent over a shared resource network through a first limited bandwidth link s and wherein a first part of each image encoded in the second format with the second combination of
resolution, frame rate and bits per pixel is sent over the shared resource network through the first limited bandwidth link and a second part of each image encoded in the second format with the second combination of resolution, frame rate and bits per pixel is sent over the shared resource network through a second limited bandwidth link.

13. The method of claim 12 wherein the first limited bandwidth link and/or the second limited bandwidth link are cables.

14. The method of claim 12 or 13, wherein the first format is selected from a legacy format and an HD format and the resolution is selected from a legacy resolution and a 2MP resolution.

15. The method of any of the claims 12 to 14, wherein the second format is selected from an upgraded format and a 4K format and the resolution is selected from an upgraded resolution and an 8MP resolution.

16. The method of any of the claims 12 to 15, wherein a first fraction of each image in the second format and the images in the first format are sent through the first bandwidth limited link and a second fraction of each image in the second format are sent through the second bandwidth limited link, whereby the first and second fractions add up to 1.

17. The method of any of the claims 12 to 16, wherein a first fraction is 3/8 of each image in the second format and the second fraction is 5/8 of each image in the second format.

18. The method of any of the claims 12 to 17, wherein images encoded in the second format are divided in a left part and a right part.

19. The method of claim 18, wherein the left part of each image contains a first fraction such as 3/8 of the pixels of that image and the right part of each image represents the remaining second fraction such as 5/8 of that image.

20. The method according to claim 18 or 19, further comprising reconstructing the entire image by displaying the left part and the right part next to each other on a second display.
21. An encoding engine for encoding images from at least one input source, the images having a first format with a first combination of resolution, frame rate and bits per pixel, whose product has a first product value and in a second format with a second combination of resolution, frame rate and bits per pixel, whose product value is higher than the first product value; the encoding engine having means for sending images encoded in the first format with the first combination of resolution, frame rate and bits per pixel over a shared resource network through a first limited bandwidth link and for means for encoding a first part of each image having the second format with the second combination of resolution, frame rate and bits per pixel for sending over the shared resource network through the first limited bandwidth link and a second part of each image encoded in the second format with the second combination of resolution, frame rate and bits per pixel for sending over the shared resource network through a second limited bandwidth link.

22. The encoding engine of claim 21 wherein the first limited bandwidth link and/or the second limited bandwidth link are cables.

23. The encoding engine of claim 21 or 22, wherein the first format is selected from a legacy format and HD format, and the resolution is selected from a legacy resolution and a 2MP resolution.

24. The encoding engine of any of the claims 21 to 23, wherein, the second format is selected from an upgraded format and a 4K formation and the resolution is selected from an upgraded resolution and an 8MP resolution.

25. The encoding engine of any of the claims 21 to 24, wherein a first fraction of each image in the second format and the images in the first format are sent through the first bandwidth limited link and a second fraction of each image in the second format are sent through the second bandwidth limited link, whereby the first and second fractions add up to 1.

26. The encoding engine of any of the claims 21 to 25, wherein images encoded in the second format are divided in a left part and a right part.

27. The encoding engine of claim 26, wherein the left part of each image contains a first fraction such as 3/8 of the pixels of that image and the right part of each image
represents the remaining second fraction such as 5/8 of that image.

28. The encoding engine according to claim 26 or 27, adapted to reconstruct the entire image by displaying the left part and the right part next to each other on a second display.

29. The encoding engine of any of the claims 21 to 28, wherein a first fraction of each image encoded in the second format is sent as a first stream over the network and the remaining second fraction of each image encoded in the second format is sent as a second stream over the network.

30. A decoding engine for decoding images received from at least one input source, the images having a first format with a first combination of resolution, frame rate and bits per pixel the product of which is a first product value and in a second format with a second combination of resolution, frame rate whose product value is higher than the first product value; the decoding engine having means for decoding received images encoded in the first format with the first combination of resolution, frame rate and bits per pixel over a shared resource network through a first limited bandwidth link and means for decoding a first part of each received image having the second format with the second combination of resolution, frame rate and bits per pixel received over the shared resource network through the first limited bandwidth link and means for decoding a second part of each received image encoded in the second format with the second combination of resolution, frame rate and bits per pixel received over the shared resource network through a second limited bandwidth link.

31. The decoding engine of claim 30, wherein the first format is selected from a legacy format and HD format, and the resolution is selected from a legacy resolution and a 2MP resolution.

32. The decoding engine of claim 30 or 31, wherein, the second format is selected from an upgraded format and a 4K format and the resolution is selected from an upgraded resolution and an 8MP resolution.

33. The decoding engine of any of the claims 30 to 32, wherein a first fraction of each image in the second format and the images in the first format are received from the first bandwidth limited link and a second fraction of each image in the second
format is received through the second bandwidth limited link, whereby the first and second fractions add up to 1.

34. The decoding engine of any of the claims 30 to 33, wherein images encoded in the second format are divided in a left part and a right part.

35. The decoding engine of claim 34, wherein the left part of each image contains a first fraction such as 3/8 of the pixels of that image and the right part of each image represents the remaining second fraction such as 5/8 of that image.

36. The decoding engine according to claim 34 or 35, adapted to reconstruct the entire image by displaying the left part and the right part next to each other on a second display.

37. The decoding engine of any of the claims 30 to 36, wherein a first fraction of each image encoded in the second format is sent as a first stream over the network and the remaining second fraction of each image encoded in the second format is sent as a second stream over the network.

38. A computer program product comprising software which when executed on a processing engine is adapted to encode and send images encoded in the first format with a first combination of resolution, frame rate and bits per pixel over a shared resource network through a first limited bandwidth link such as a first cable and to encode a first part of each image having the second format with a second combination of resolution, frame rate and bits per pixel sending over the shared resource network through the first limited bandwidth link such as the first cable and a second part of each image encoded in the second format with the second combination of resolution, frame rate and bits per pixel for sending over the shared resource network through a second limited bandwidth link such as a second cable.

39. A computer program product comprising software which when executed on a processing engine is adapted to decode received images encoded in a first format with a first combination of resolution, frame rate and bits per pixel over a shared resource network through a first limited bandwidth link such as a first cable and to decode a first part of each received image having the second format with the second combination of resolution, frame rate and bits per pixel received over the
shared resource network through the first limited bandwidth link such as the first
cable and to decode a second part of each received image encoded in the second
format with the second combination of resolution, frame rate and bits per pixel
received over the shared resource network through a second limited bandwidth
link such as a second cable.

40. A non-transitory signal storage medium, storing the computer program product of
claim 38 or 39.

41. A display system for displaying image data comprising at least one input source
encoding images to be displayed in a first format with a first resolution and in a
second format with a second resolution higher than the first; a first display for
displaying images with the first resolution and a second display for displaying
images with the second resolution; a shared resource network linking the at least
one input source with the first and second displays; wherein the images encoded
in the first format with the first resolution are sent over the shared resource network
through a first limited bandwidth link such as a first cable and wherein a first part
of each image encoded in the second format with the second resolution is sent
over the shared resource network through the first limited bandwidth link such as
the first cable and a second part of each image encoded in the second format with
the second resolution is sent over the shared resource network through a second
limited bandwidth link such as a second cable.

42. The display system of claim 41, wherein the first format is selected from a legacy
format and HD format, and the first resolution is selected from a legacy resolution
and a 2MP resolution.

43. The display system of claim 41 or 42, wherein, the second format is selected from
an upgraded format and a 4K formation and the second resolution is selected from
an upgraded resolution and an 8MP resolution.

44. The display system of any of the claims 41 to 43, wherein the first and second
cables are 10GE cables.

45. The display system of any of the claims 41 to 44, wherein a first fraction of each
image in the second format and the images in the first format are sent through the
first bandwidth limited link and a second fraction of each image in the second
format are sent through the second bandwidth limited link, whereby the first and second fractions add up to 1.

46. The display system of according to any of the claims 41 to 45 wherein two 10GE cables are required to stream video data in the first and second formats whereby the first and second formats are HD and 4K formats respectively.

47. The display system of any of the claims 41 to 46, wherein images encoded in the second format are divided in a left part and a right part.

48. The display system of claim 47, wherein the left part of each image contains a first fraction such as 3/8 of the pixels of that image and the right part of each image represents the remaining second fraction such as 5/8 of that image.

49. The display system according to claim 47 or 48, adapted to reconstruct the entire image by displaying the left part and the right part next to each other on a second display.

50. The display system of any of the claims 41 to 49, wherein a first fraction of each image encoded in the second format is sent as a first stream over the network and the remaining second fraction of each image encoded in the second format is sent as a second stream over the network.

51. A method for displaying image data, the method comprising:

at least one input source encoding images to be displayed in a first format with a first resolution and in a second format with a second resolution higher than the first;

displaying images with the first resolution and images with the second resolution on different displays; wherein the images encoded in the first format with the first resolution are sent over a shared resource network through a first limited bandwidth link such as a first cable and wherein a first part of each image encoded in the second format with the second resolution is sent over the shared resource network through the first limited bandwidth link such as the first cable and a second part of each image encoded in the second format with the second resolution is sent over the shared resource network through a second limited bandwidth link such as a second cable.
52. The method of claim 51, wherein the first format is selected from a legacy format
and an HD format and the first resolution is selected from a legacy resolution and
a 2MP resolution.

53. The method of claim 51 or 52, wherein the second format is selected from an
upgraded format and a 4K format and the second resolution is selected from an
upgraded resolution and an 8MP resolution.

54. The method of any of the claims 51 to 53, wherein a first fraction of each image in
the second format and the images in the first format are sent through the first
bandwidth limited link and a second fraction of each image in the second format
are sent through the second bandwidth limited link, whereby the first and second
fractions add up to 1.

55. The method of claim 54, wherein a first fraction is 3/8 of each image in the second
format and the second fraction is 5/8 of each image in the second format.

56. The method of any of the claims 51 to 54, wherein images encoded in the second
format are divided in a left part and a right part.

57. The method of claim 56, wherein the left part of each image contains a first fraction
such as 3/8 of the pixels of that image and the right part of each image represents
the remaining second fraction such as 5/8 of that image.

58. The method according to claim 56, or 57 further comprising reconstructing the
entire image by displaying the left part and the right part next to each other on a
second display.

59. An encoding engine for encoding images from at least one input source, the
images having a first format with a first resolution and in a second format with a
second resolution higher than the first; the encoding engine having means for
sending images encoded in the first format with the first resolution over a shared
resource network through a first limited bandwidth link such as a first cable and for
means for encoding a first part of each image having the second format with the
second resolution for sending over the shared resource network through the first
limited bandwidth link such as the first cable and a second part of each image
encoded in the second format with the second resolution for sending over the
shared resource network through a second limited bandwidth link such as a second cable.

60. A decoding engine for decoding images received from at least one input source, the images having a first format with a first resolution and in a second format with a second resolution higher than the first; the decoding engine having means for decoding received images encoded in the first format with the first resolution over a shared resource network through a first limited bandwidth link such as a first cable and means for decoding a first part of each received image having the second format with the second resolution received over the shared resource network through the first limited bandwidth link such as the first cable and means for decoding a second part of each received image encoded in the second format with the second resolution received over the shared resource network through a second limited bandwidth link such as a second cable.

61. A computer program product comprising software which when executed on a processing engine is adapted to encode and send images encoded in the first format with the first resolution over a shared resource network through a first limited bandwidth link such as a first cable and to encode a first part of each image having the second format with the second resolution sending over the shared resource network through the first limited bandwidth link such as the first cable and a second part of each image encoded in the second format with the second resolution for sending over the shared resource network through a second limited bandwidth link such as a second cable.

62. A computer program product comprising software which when executed on a processing engine is adapted to decode received images encoded in the first format with the first resolution over a shared resource network through a first limited bandwidth link such as a first cable and to decode a first part of each received image having the second format with the second resolution received over the shared resource network through the first limited bandwidth link such as the first cable and to decode a second part of each received image encoded in the second format with the second resolution received over the shared resource network through a second limited bandwidth link such as a second cable.

63. A non-transitory signal storage medium, storing the computer program product of claim 61 or 62.
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Two (partial) lines of video data

FIG 4
FIG 5
## INTERNATIONAL SEARCH REPORT

A. CLASSIFICATION OF SUBJECT MATTER

INV. H04N21/4363 H04N21/81 H04N19/597 H04N19/33

ADD.

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

H04N

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPO-Internal , WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

<table>
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<th>Relevant to claim No.</th>
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☐ Further documents are listed in the continuation of Box C. ☑ See patent family annex.

* Special categories of cited documents :

- "A" document defining the general state of the art which is not considered to be of particular relevance
- "E" earlier application or patent but published on or after the international filing date
- "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
- "O" document referring to an oral disclosure, use, exhibition or other means
- "P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"Z" document member of the same patent family

Date of the actual completion of the international search

16 February 2017

Name and mailing address of the ISA

European Patent Office, P.B. 5818 Patentlaan 2
NL - 2280 HV Rijswijk
Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016

Date of mailing of the international search report

24/02/2017

Authorized officer

D'Attilia, Marco
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